CORRIGENDUM.

Novitates Zoologicae Vol. **41** (4): 321–344. Hastings: Cellularine Polyzoa.

The scales given with the figures are divided into tenths and twentieths of a millimetre.

The decimal point has been omitted in Figs. 272, 275, 276 A–E, 277, 278, 279 A, 279 C. The scales for Figs. 276 F and 279 B each represent a whole millimetre, and are correct as printed.

NOTES ON SOME CELLULARINE POLYZOA (BRYOZOA).

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(With 8 text-figures.)

THE Polyzoa discussed in this paper have been examined in the course of my work on the collections of the Discovery and other antarctic expeditions, but do not come within the scope of my unpublished report.

The genus *Emma* and a section of the genus *Bugula* are revised, with description of new species, and examination of various recorded specimens; the Challenger material of *Caulibugula* has been re-examined, and a new species of the genus described from New Zealand material collected by the Discovery; *Dimorphozoum* Levinsen is shown to be a synonym of *Beania*. *Bugula expansa* sp. n., a New Zealand species from the Terra Nova collection, has a curious structure at the base of the colony, which I have referred to as the foot. Its morphology could probably only be made out by examining developmental stages.

The classification of the Polyzoa has not yet reached a point where subspecies, forms, races, etc., can be adequately discriminated, and I therefore use the term variety in a wide sense to cover all such categories.

In the statements of distribution of the species a published record is indicated by the author's name, the reference being given in the statement of synonymy. Specimens in the British Museum are indicated by their registered number, sometimes with the name of the collector or donor added; specimens from the Waters Collection in the Manchester Museum are indicated by "Manchester Mus.", and in the Liverpool University Museum by "Liverpool Mus.". "Terra Nova" means British Antarctic Expedition (1910), and "Discovery" the Discovery Investigations (1925 onwards).

I am very grateful to the Riksmuseum, Stockholm, the University Museums of Zoology at Berlin, Cambridge and Liverpool, and the Manchester Museum for lending specimens, and to Dr. C. Crossland for his material from Ghardaqa, Red Sea.

I should also like to thank Sir Sidney Harmer, K.B.E., F.R.S., for his help and encouragement.

Emma Gray, 1843.

My examination of type and other authentic specimens of *Emma* in the British Museum shows that three species have been confused under *E. crystallina*, and that Waters' variety of *E. cervicornis* is distinguished by quite definite characters.

All the species of *Emma* have branches that spring from the frontal surface of the zooecia and originate in a uniserial joint, in addition to those formed by bifurcation, which, except in *E. cyathus*, are biserial from the start. In my descriptions I have called them frontal branches.

Waters (1887, p. 88) mentioned the Straits of Magellan in the distribution of *E. crystallina*, on the evidence, no doubt, of a specimen in the Busk collection

(99.7.1.672), which proves, however, to belong to *E. rotunda*. Busk received the specimen from Miss Gatty, from whom he obtained material from many parts of the world. The genus being otherwise recorded solely from Australia and New Zealand, and being absent from the S. American collections of the Discovery Expedition, I hesitate to accept the evidence of this one slide, although there is nothing in the appearance of the slide, nor in its history as far as known, to throw any doubt on the correctness of its locality.

KEY TO THE SPECIES OF *EMMA*.

1	All joints uniserial	*E. cyathus* (not discussed here [1])
	Joints at bifurcation biserial, those at origin of frontal branches uniserial	2.
2	All internodes of 3 zooecia	3.
	Non-fertile internodes of 2 zooecia except at bifurcation . . .	4.
3	Scuta simple on non-fertile, simple or forked on fertile zooecia, 1 or 2 spines in axil	6. *E. tricellata*
	Scuta clavate, larger on fertile zooecia, 2 to 4 spines in axil .	7. *E. buskii*
4	Opesia roundly triangular, the largest spine opposite its apex, an internal spine for attachment of parietal muscles, fertile internodes of 2 zooecia with 1 or 2 ovicells not immersed in zooecia (? in kenozooecia), scuta only found on fertile zooecia, placed near ovicell . . .	2. *E. triangula*
	Opesia semicircular or oval, large spines not placed in definite relation to its symmetry, no internal spine, fertile internodes [2] of 3 zooecia, with 1 ovicell which is immersed in a zooecium, scuta, when present, placed near proximal end of opesia	5.
5	Lateral avicularia paired (i.e. one on each zooecium of internode), their palatal surface facing outward, no scuta, no frontal avicularia	1. *E. crystallina*
	Lateral avicularia paired, or single (i.e. only one to an internode), or absent, palatal surface facing more or less towards apex of branch, frontal avicularia and scuta present (sometimes with very limited distribution in colony)	6.
6	Scuta present on most zooecia, cervicorn or forked, lateral avicularia usually paired when present, aperture oval, 5 or 6 distal spines	7.
	Scuta only on fertile zooecia, unbranched, lateral avicularia single except on fertile internodes, aperture round, 3 or 4 distal spines .	3. *E. rotunda*
7	Lateral avicularia present on some internodes at least, internodes tapering quickly, frontal avicularia absent except on fertile internodes, larger spines often pod-like	4. *E. cervicornis*
	Lateral avicularia absent, internodes with tubular proximal portion, no frontal avicularia on fertile internodes but sometimes present on median zooecium at bifurcation, spines not pod-like	5. *E. cervicornis* var. *watersi*.

1. **Emma crystallina** Gray (text-fig. 272, C).

Emma crystallina Gray 1843, p. 293 ; Harmer 1923, p. 357 (part).

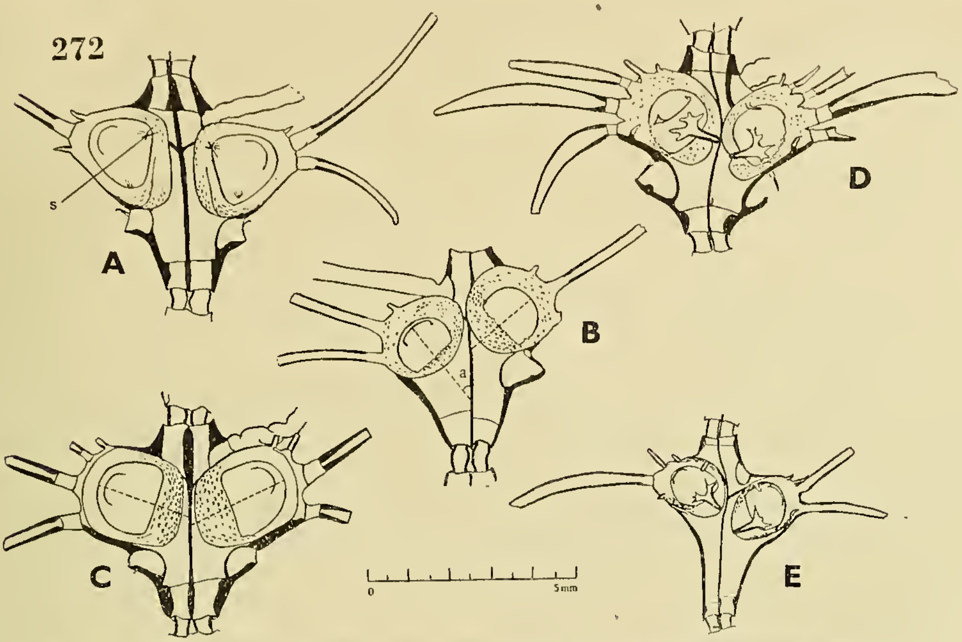
Distribution.—New Zealand (Gray ; 35.2.28.2, the type specimen).

The zooecia of the type specimen of *E. crystallina* are turned away from the axis of the branch, so that a line bisecting the opesia forms a greater angle

[1] See Harmer, 1923, p. 357.

[2] Unknown in *E. crystallina*.

with the main axis of the branch than it forms in *E. rotunda*, where the turning is less marked (see angle a in text-figs. 272, C and B). The opesia is almost semi-circular. In all but the lowest internodes of the branch there is a small lateral avicularium on each zooecium, with the palatal surface nearly parallel to the longitudinal axis of the branch, thus facing outward. The two outer spines of the distal series of 4 or 5 on each zooecium are conspicuously larger than the



TEXT-FIG. 272.—A. *Emma triangula* sp.n., an internode from the type specimen, 87.12.10.44b. s, spine with parietal muscles. Internodes without rootlets are more nearly symmetrical.—— B. *Emma rotunda* sp.n., an internode from Hooker's specimen from Campbell Is., 99.7.1.670.—— C. *Emma crystallina* Gray, an internode from the type specimen, 35.2.28.2.——D. *Emma cervicornis* MacG., an internode from 99.5.1.334. One of the lateral avicularia is broken.——E. *E. cervicornis* var. *watersi* var. n., an internode from the type specimen, 88.1.2.3.

rest. The position of the enlarged spines bears no constant relation to the symmetry of the opesia. The cryptocyst of the median zooecium at the bifurcations is very oblique. Scuta are absent and the specimen has no ovicells.

I have seen no other specimen that can be attributed to this species. Busk (1852*b*) confused two species, both of which appear to be distinct from *E. crystallina* Gray, and are discussed below (2. *E. triangula*, 3. *E. rotunda*). MacGillivray also used the name *E. crystallina* for *E. rotunda*, and Levinsen used it for *E. triangula*.

2. **Emma triangula** sp.n. (text-fig. 272, A).

Emma crystallina Busk, 1852*a*, p. 373; 1852*b* (part), p. 28, pl. XL, figs. 1–3 (Rattlesnake); Harmer, 1923, p. 357 (part).
Menipea crystallina Busk, 1884, p. 23; Levinsen, 1909, pp. 132, 133, pl. II, figs. 1*a*, 1*b*.
Not *Emma crystallina* Gray.
Not *Menipea crystallina* MacGillivray (= *E. rotunda* sp.n.).

Distribution.—Port Phillip (Busk; 87.12.10.37 and 44*b*; 88.11.14.271 and 372; 97.5.1.282 and 283); St. 161, Challenger (Busk; 87.12.9.102);

Bass Strait (Busk; 99.7.1.5738, Rattlesnake; 34.2.16.10; 1938.12.14.1); Palliser Bay, Wairarapa, New Zealand (1938.1.20.2); Cape Maria Van Diemen, New Zealand, 35–40 fms., 13.ix.1911 (Terra Nova St. 144, 1939. 2.2.4); 34° 11′ S., 172° 8′ E., New Zealand, 84 m., 17.viii.1932 (Discovery St. 935; 1939.2.2.6); 34° 11′ S., 172° 10′ E., New Zealand, 92–98 m. (Discovery St. 934, 1939.2.2.7); New Zealand (Terra Nova, 1939.2.2.3).

Type.—87.12.10.44*b*.

This species was well figured by Levinsen, who showed the ovicells, and by Busk. It resembles typical *E. crystallina* in its avicularia, but the opesia is roundly triangular rather than semicircular. One or two spines in the distal series of 3 (or occasionally 4) are enlarged, and the largest is placed symmetrically opposite the apex of the triangle. Where there are 3 spines this is the middle one. The other spines are small and pointed, but not placed on the basal surface as in Busk's figure 3. The cryptocyst of the median zooecium at the bifurcation is oblique as in *E. crystallina.* The outline of the aperture varies, sometimes being nearly symmetrical as in my figure, more often drawn out at the proximal corner as in Busk's figure 2.

The parietal muscles form two groups, one in each proximal corner of the opesia (text-fig. 272, A). One bundle is attached to a little thickening of the outer wall, the other to a blunt-ended spine (s), which springs from the transverse wall separating the distal zooecium, and frequently projects beyond the edge of the cryptocyst so that its head is quite conspicuous in frontal view.

As far as my observations go, the fertile internodes are always on the frontal branches. They consist of two zooecia, both of which usually bear ovicells, though sometimes only one is fertile. Levinsen described the ovicells as immersed in kenozooecia. The fertile zooecia commonly bear a spine-like scutum placed near the ovicell.

Busk's material from Bass Straits, both in the Rattlesnake and Challenger collections, belongs to this species. His specimens from New Zealand (B.M. Cat.) belong to *E. rotunda.* It is impossible to tell to which species the New Zealand specimens of Livingstone (1929, p. 55) belonged.

3. **Emma rotunda** n.sp. (text-fig. 272, B).

Menipea crystallina MacGillivray, 1881, p. 31, pl. LVIII, figs. 2–2*b*.
Emma crystallina Busk, 1852*b*, p. 28 (part, New Zealand); Harmer, 1923, p. 357 (part); Hastings, in Cranwell and Moore, 1938, p. 395.
Not *Emma crystallina* Gray.

Distribution.—Queenscliff (MacGillivray); Poor Knights Is., New Zealand (Hastings; Miss L. B. Moore, 1937.4.6.2); Campbell Is. (1939.4.22.1 [1]; Hooker, 99.7.1.670); New Zealand (1938.5.2.2; 99.7.1.671); Great Swan Point, Tasmania (46.8.5.18); Tasmania (Manchester Mus.); New South Wales (1938.9.2.1); Bondi Bay, New South Wales (Manchester Mus.); ? Straits of Magellan (99.7.1.672, see p. 321 above).

Type.—1937.4.6.2.

This species, described and figured by MacGillivray as *E. crystallina*, differs from *E. crystallina* Gray in the shape of its zooecia. They are less turned from the median axis of the branch (text-fig. 272, B), the aperture is circular rather than oval and the granular cryptocyst, whose proximal part descends steeply,

[1] 1939.4.22.1. This is the British Museum Catalogue specimen (51.1.10.12) re-registered.

appears of fairly even width all round. The opesia is semicircular. In dried specimens the orifice is sometimes seen to be stretched open, forming the circular hole in the frontal membrane figured by MacGillivray. The cryptocyst of the median zooecium at the bifurcation is much less oblique than in *E. crystallina*. Simple spine-like scuta are sometimes present on the fertile zooecia, and there may be a frontal avicularium on the median zooecium at the bifurcations. Many internodes have no lateral avicularia, but there is often one on the more distal of the two zooecia of an internode. The lateral avicularium projects more from the lateral wall of the zooecium than in *E. crystallina* and, its position appearing to be related to the angle of the zooecia, its palatal surface faces obliquely distally instead of straight outwards. Non-fertile internodes do not have more than one avicularium, but in fertile internodes the fertile zooecium, which is the first zooecium of the internode, may also have one. It is a little larger than the avicularium on the second zooecium, and is placed more frontally. The ovicell is immersed in the third zooecium of the internode.

The difference between this species and *E. triangula* is clearly shown in the figures of MacGillivray and Levinsen. The fertile internodes, in particular, are markedly different (see key).

E. rotunda resembles *E. cervicornis* in the structure of its fertile internodes, except that there is no frontal avicularium. It also resembles *E. cervicornis* in the shape and direction of the lateral avicularia, but differs in their being single on non-fertile internodes, *E. cervicornis* usually having two to an internode. *E. cervicornis* further differs in its cervicorn scuta, and in the absence of frontal avicularia at the bifurcations. *E. cervicornis* usually has 5 or 6 spines, of which 2 or 3 may be pod-like. The number in *E. rotunda* is 3 or 4, of which 1 to 3 may be large, but not pod-like. The little outer spine directed frontally, which is common in *E. cervicornis* (text-fig. 272, D, E), is usually absent in *E. rotunda*, but is present in the Tasmanian material.

One of the two specimens from Campbell Is. (99.7.1.670) is typical (text-fig. 272, B). The other approaches *E. cervicornis* var. *watersi* in having the internodes rather long and tubular proximally, and no lateral avicularia. It differs from the variety in the shape of the aperture and cryptocyst, in the number and arrangement of the spines, and in the larger zooecia, in all of which it agrees with *E. rotunda*. It is labelled " *Emma crystallina* Gray MS." in Gray's writing, and Busk has also labelled it *E. crystallina*, but it is clearly distinct from both the type specimen of that species and from the species figured in the B.M. catalogue as *E. crystallina* (= *E. triangula*).

4. **Emma cervicornis** MacG. (text-fig. 272, D).

Emma cervicornis MacGillivray, 1869, p. 127 ; Harmer, 1923, p. 357.
Menipea cervicornis MacGillivray, 1881, pp. 34, 32, pl. LVIII, figs. 4–4*b* ; Levinsen, 1909, pp. 59, 132, 133, pl. II, figs. 4*a*, 4*b*.

Distribution.—Queenscliff (MacGillivray) ; Australia (99.5.1.334 ; Manchester Mus. from E. C. J. [Jelly]) ; Port Phillip (87.12.10.36).

There is also a specimen from MacGillivray, without locality, 97.5.1.256.

Typical *E. cervicornis*, as represented in MacGillivray's figures and by one of his specimens (97.5.1.256), has an oval or semicircular opesia. There are two lateral avicularia on most internodes except the lowest in the branch, where there may only be one, but they are larger and more prominent than those of

E. crystallina and their palatal surface faces more distally so that their beaks project more from the branch. Frontal avicularia are only found in relation to ovicells. There are 5 or 6 distal spines, the 6th when present being the outer one, which is very small, is not in line with the others and is directed frontally (text-fig. 272, D, and MacGillivray, fig. 4*b*). The other 5 are graded in size, the outer two being the largest and often being pod-like. There is sometimes a small spine on the inner border of the aperture. In the fertile internodes the first of the three zooecia is fertile and its ovicell is immersed in the third, whose avicularium surmounts the ovicell. The scutum of the fertile zooecium is apt to be particularly richly branched.

The variety recognized by Waters appears to be clearly distinguished (see below).

5. **Emma cervicornis** var. **watersi** var.n. (text-fig. 272, E).

Menipea cervicornis var. Waters, 1887, p. 88, pl. IV, fig. 1.

Distribution.—Shark Is., Port Jackson (Waters; Manchester Mus. and 88.1.2.3, parts of the type material); Port Phillip Heads (88.11.14.415); off Port Phillip, 33 fms. (99.7.1.669); Kermadec Isles (55.12.7.175).

Waters' variety resembles *E. cervicornis* in possessing branched scuta. Many are, however, simply forked. The general distribution of its spines is similar, but there are not more than 5, and they are usually slender. Var. *watersi* resembles *E. rotunda* in the presence of a frontal avicularium on the median zooecium at the bifurcation (not seen in 88.11.14.415) and in the absence of frontal avicularia with the ovicells. It differs from both *E. cervicornis* and *E. rotunda* in the complete absence of lateral avicularia, and in its smaller zooecia with longer tubular proximal portion.

6. **Emma tricellata** Busk.

Emma tricellata Busk, 1852*a*, p. 373; 1852*b*, p. 28, pl. XLI, figs. 1 and 2; Harmer, 1923, p. 357.
Menipea tricellata MacGillivray, 1881, p. 34, pl. LVIII, figs. 5–5*b*.

Distribution.—Bass Strait, 45 fms. (Busk; 99.7.1.6520 Rattlesnake, the type specimen); George Town, Tasmania, Hooker (54.11.15.71; 99.7.1.729, 730 and 5576); Queenscliff (MacGillivray); Port Phillip (88.11.14.258, 346; 97.5.1.253, 254, 275–277, 279 and 281); Sydney, 10 fms. (99.7.1.729A); New Zealand, Hooker (Busk; 99.7.1.731 and 732).

There is also a specimen from MacGillivray without locality (97.5.1.278).

The chief differences between *E. tricellata* and *E. buskii* (p. 327) can be seen in MacGillivray's figures, namely the longer internodes and simple scuta of *E. tricellata*. In both, the scutum is more developed on the fertile zooecium. In *E. buskii* this development takes the form of an enlargement of the elavate head (cf. Levinsen, fig. 3*a*). In *E. tricellata* the scutum is notched or forked, in contrast to the simple spine-like scuta of other zooecia, or, in colonies with few scuta, it is present as a simple spine on the fertile zooecium and absent from its neighbours. *E. tricellata* has, on the average, a smaller number of distal spines on the median zooecium at the bifurcation. Stout rootlets are present in both, and I have been unable to satisfy myself that there is any constant difference in the position of the avicularium. The fertile internodes are similarly constructed in the two species.

E. tricellata, as separated by these characters, is rather variable. At one extreme the specimens have internodes very little longer than those of *E. buskii*, the median zooecium at a bifurcation has a scutum with a blunt and slightly expanded end, suggesting the clavate scutum of *E. buskii*, the non-fertile zooecia have usually 4 outer and 1 inner distal spine as in *E. buskii*. The median zooecium usually has 4 spines, of which two are apical and show in the axil, but it may resemble *E. buskii*, which generally has 5, with 3 apical. MacGillivray's figure represents a specimen approximating to this type. In one such specimen many of the scuta have a slightly wider tip (88.11.4.346).

At the other extreme are specimens with longer, more tapering, internodes. There is usually 1 apical spine in the axil (sometimes 2) and the axillary zooecium has a simple, spine-like scutum. Some of the non-fertile zooecia are without scuta, and they have only 2 or 3 outer spines of which not more than one is large. Busk's figure, drawn from his Tasmanian material, which is variable, approximates to this type, and so does the type specimen. The material from Port Phillip forms a series connecting these two types.

At one extreme *E. tricellata* approaches *E. buskii*, whose geographical range falls within the larger area occupied by *E. tricellata*, and it may well be that *E. buskii* is no more than the extreme term in the variation of *E. tricellata*. The two forms are, however, distinguishable in the material before me.

7. **Emma buskii** (Wyv.-Thom.).

Menipea buskii Wyville-Thomson, 1858, p. 144, pl. XII, fig. 1; MacGillivray, 1881, p. 35, pl. LVIII figs. 6–6*b*.
Menipea buski Levinsen, 1909, pp. 131–133, pl. II, figs. 3*a–c*.
Emma buskii Harmer, 1923, p. 357.

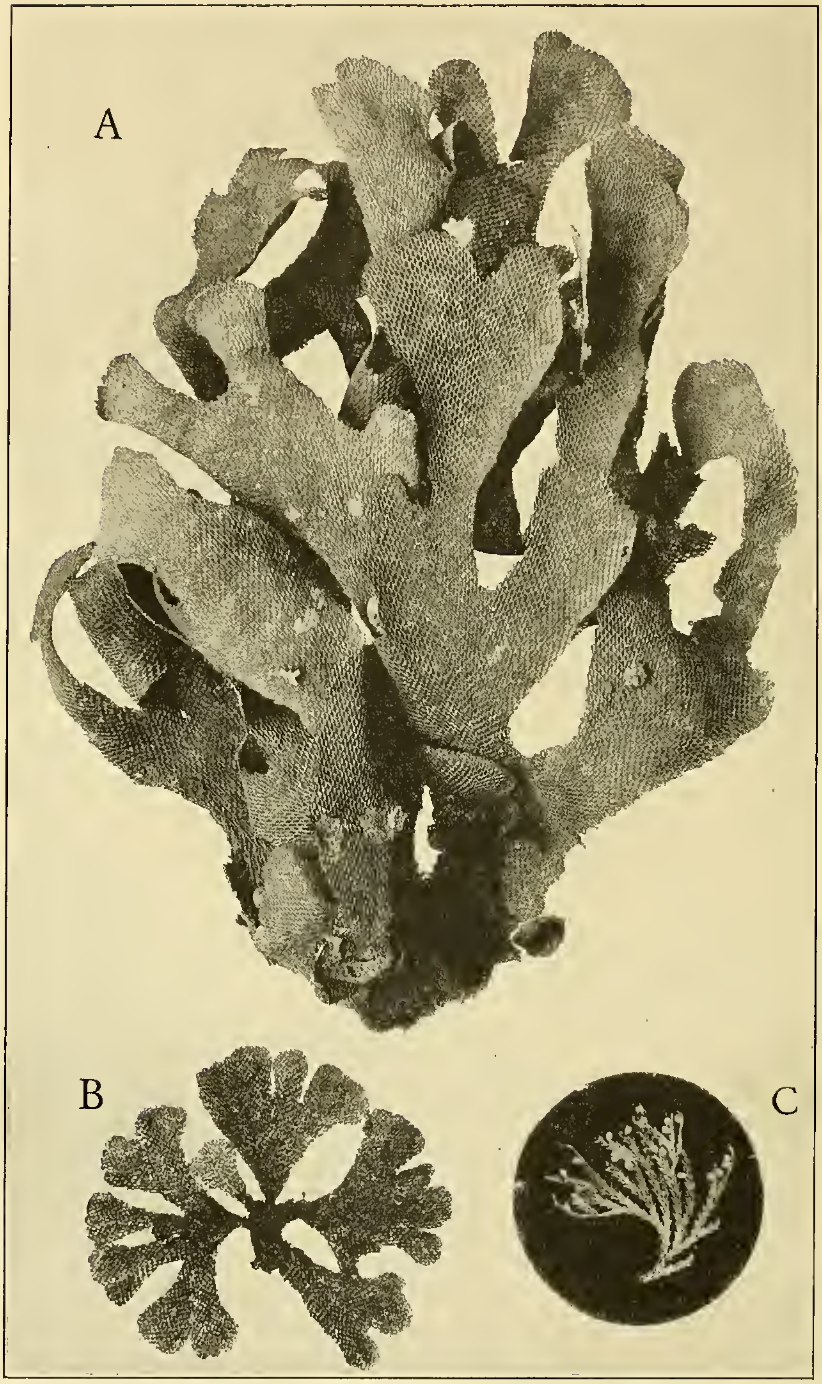
Distribution.—Bass Str. (Thomson; Thomson, 99.7.1.660); Queenscliff (MacGillivray); Port Phillip Heads (87.12.9.121; 97.5.1.251 and 252); Hobson Bay, Australia (99.7.1.661 and 658).

This species is discussed under *E. tricellata*.

Dimorphozoum Levinsen, a synonym of **Beania** (text-fig. 273, A).

The genotype of *Dimorphozoum* Levinsen (1909, pp. 96, 107) is *Flustra nobilis* Hincks (1891, p. 288), described from specimens obtained by Jelly from Port Elizabeth, S. Africa. Levinsen introduced his genus after examination of material from the same source. He described it as consisting of two layers back to back, a cheilostome-layer and a ctenostome-layer. Specimens from Port Elizabeth given to the Cambridge Museum [1] by Miss Jelly appear to be part of the same material; the two layers are present and, as with Levinsen's specimens, there are colonies of *Chaperia capensis*. The ctenostome-layer contains numerous brown bodies. Levinsen regarded it as an integral part of the colony, chiefly because it was present throughout and was connected with the zooecia by rosette-plates. This layer is, however, not present on all the colonies in the Cambridge material, nor does it cover the whole basal surface of those on which it is found, moreover, small patches of it are present at two points on the frontal surface, where they obliterate the underlying zooecia. The supposed rosette-plates prove to be minute basal spines resembling those of *Flustra echinata* Kluge (1914, p. 658) but very much smaller, and usually unbranched. They are developed irrespective of whether the ctenostome-layer is present or not, and in Hasenbank's material (1932, p. 335) they were branched.

[1] Part of this material is now in the British Museum, registered 34.4.6.1.



TEXT-FIG. 273.—A. *Beania nobilis* (Hincks), Locality unknown, 91.10.16.1. nat. size.——B. *Beania bilaminata* (Hincks), New Zealand, 99.7.1.6614. nat. size.——C. *Bugula neritinoides* Busk MS. sp.n. 99.7.1.4650. x 2.

There is thus no reason for supposing that the ctenostome-layer is anything but an incrustation of another species. As all the material is dry it is probably impossible to identify the species, but the two-lipped orifice appears to relate it to *Flustrella* and *Elzerina* (see Harmer, 1915, p. 39), rather than to *Alcyonidium*,

The cheilostome-layer, which is the whole zoarium of Hincks' species, agrees very closely with the description and figures given by Hasenbank, who found no trace of a ctenostome-layer. It resembles *Beania* in the tubular connections of the zooecia, and their shape. The small tooth-like spines on the distal edge, the branched marginal spines, the basal spines, the pedunculate avicularia, the differentiated operculum, the very shallow ovicells and the flustrine colony are all to be found in species of *Beania*. Text-fig. 273, B, shows, for example, the flustrine colony of *Beania bilaminata* (Hincks, 1881, p. 157), a species closely related to *B. magellanica* Busk. The attachment of the avicularia to the proximal part of the zooecium is unusual in *Beania*, but is found in *Beania regularis* Thornely. *Dimorphozoum* thus becomes a synonym of *Beania*.

In material in the British Museum (Text-fig. 273, A) marginal spines are exceedingly rare, but a few are present. No basal spines are present and the basal surface is free from the encrusting Ctenostome. The ovicells can only partially accommodate the large embryo which projects into the cavity of the zooecium.

Bugula Oken, 1815.

I have examined a number of species of *Bugula* (see key below), including three which I believe to be undescribed, which agree in having pedunculate, obliquely placed, globular ovicells, no true spines, though the distal corners of the zooecia may be pointed, the avicularium when present (it is absent in *B. neritina* and *B. neritinoides*) placed on the proximal part of the zooecium, and zigzag lines on the basal surface as described in *B. robusta* by Harmer (1926, p. 436). These lines are not always visible throughout the colony, but can be seen on the older parts, at least, in all the species. Most of these species have brownish pigment which persists in spirit, and often also in dried specimens. Traces of it can be seen in *B. vectifera* and *B. subglobosa*, and the only form in which I have found no sign of it is *B. robusta* var. *capensis*, which I have not seen in spirit. Some of the species have a short stalk consisting of more or less elongated zooecia, but this is not a constant feature of the group. If the type of bifurcation, as defined by Harmer (1926, p. 433), is considered, these species fall into two groups as follows :

Bifurcation 5. *B. robusta* MacG., *B. robusta* var. *capensis* Waters, *B. neritina* (Linn.).

Bifurcation 4. *B. neritinoides* (Busk MS.) sp.n., *B. subglobosa* Harmer, *B. vectifera* Harmer, *B. scaphoides* Kirk., *B. minima* Waters, *B. crosslandi* sp.n., *B. expansa* sp.n.

In *B. neritina* the connection of zooecia G and H at the bifurcation is sometimes rather obscure, owing in part to a projection from the side of F into the proximal part of G, which I take to be a swollen rosette-plate. The other features of the bifurcation are of characteristic type 5, the split reaching the distal end of E and the fork of H passing down the side of F into the axil, from which it separates F.

B. uniserialis Hincks (see Hastings, 1930, p. 705) possesses several of the characteristics of this group. It differs chiefly in its bifurcation, which is of type 3, and in having a long tubular proximal portion to its zooecia. Preserved specimens are colourless. The method of attachment of its colonies is unknown.

KEY TO THE SPECIES OF *BUGULA* CONSIDERED IN THIS PAPER.

1	Bifurcation of type 5	2.
	Bifurcation of type 4	4.
2	Avicularia absent	*B. neritina*
	Avicularia present	3.
3	Avicularia long-headed [1]	*B. robusta*
	Avicularia short-headed	*1. B. robusta* var. *capensis*
4	Colony robust, ovicells larger than zooecia, avicularia absent .	*2. B. neritinoides*
	Colony delicate, ovicells smaller than zooecia, avicularia present . .	5.
5	Ovicells reticulate	*3. B. scaphoides*
	Ovicells smooth	6.
6	Avicularia short-headed	7.
	Avicularia long-headed	8.
7	Avicularia attached to proximal expansion of zooecium, colony with foot	*6. B. expansa*
	Avicularia on proximal part of zooecium, but distal to proximal expansion, attachment of colony unknown	*B. subglobosa*
8	Avicularia almost level with proximal end of opesia	9.
	Avicularia proximal to opesia	*5. B. crosslandi*
9	Colony delicate straggling, avicularia small, beak forming less than half their length, ovicell with narrow border	*B. vectifera*
	Colony relatively stout and compact, avicularia large, beak forming more than half their length, ovicell with broad border . .	*4. B. minima*

1. **Bugula robusta** var. **capensis** Waters (text-figs. 274, D, E, 275 A, B).

Bugula capense Waters, 1887, pl. IV, fig. 17 (mandible).
Bugula robusta (*B. capensis* Busk MS.) Waters, 1909, p. 137, footnote.
? *Bugula neritina* var. *tenuata* Thornely, 1912, p. 142, pl. VIII, fig. 3.

Distribution.—Cape of Good Hope (Busk Coll., 99.7.1.118, 119, 120, 305, 306) ; Port Elizabeth (89.1.1.8 ; 99.5.1.1347 ; Manchester Mus. ; Jelly Coll., Cambridge Mus.) ; Grahamstown (Manchester Mus.) ; ? Cargados (Thornely).

This variety chiefly differs from typical *B. robusta* (MacGillivray, 1869, p. 129 ; Harmer, 1926, p. 435) in its avicularia, which have a more rounded head and a much shorter beak without cusps (cf. text-fig. 275, B, C). The colony when dry is a pale yellowish colour, or almost white, showing no signs of pigmentation, and the branches, which in typical *B. robusta* are straight, are curved and rather straggling in appearance. The zigzag line and joints (text-fig. 274, D) are as in *B. robusta*, but basal calcareous processes have not been seen.

[1] Comparison of text-fig. 275, B and C, or text-fig. 277, A and B, will make clear the sense in which I use the terms long-headed and short-headed.

The zooecia are similar except that the outer distal corners of the inner zooecia above the bifurcations are rounded. As the pointed distal corners have a tendency to curve forward, the zooecia without them look flatter frontally, and where the internodes are short this makes the whole branch look flat compared with typical *B. robusta.* When an avicularium is present on one of the axillary zooecia it is smaller and rather different in shape (text-fig. 275, A), having no

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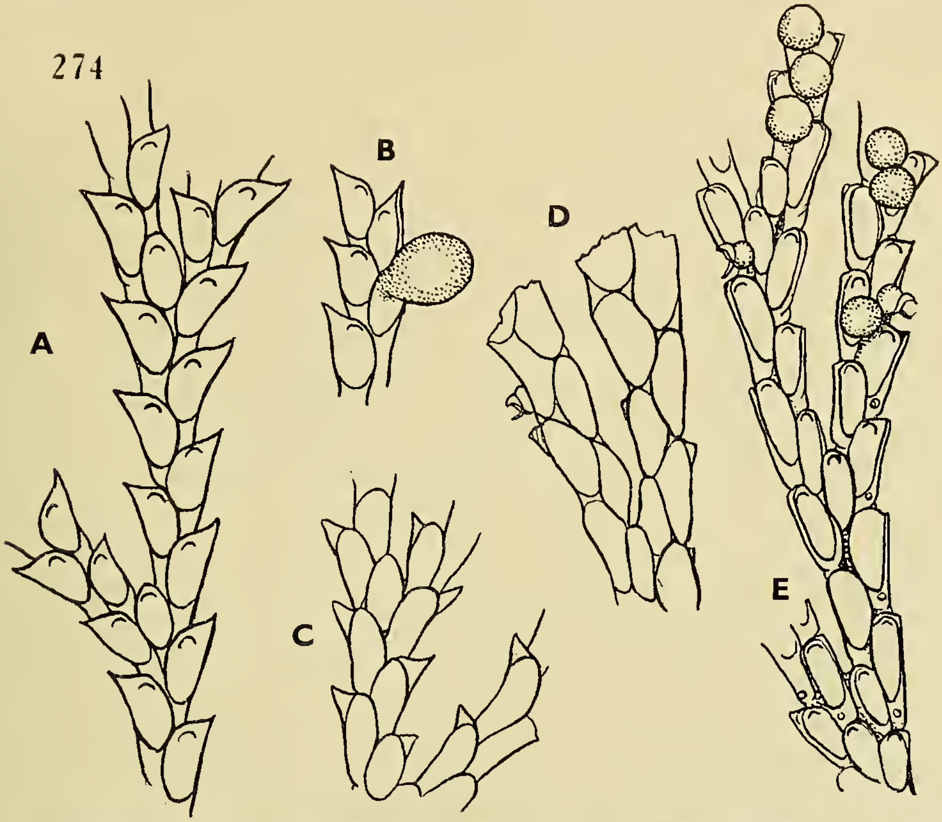

Text-fig. 274.—Tracings of hitherto unpublished pencil drawings by Busk :——A, B, C. *Bugula neritinoides* sp.n. (Busk MS.). A, Frontal view ; the upper bifurcation is the more typical. B, Frontal view with ovicell. C, Basal view.——D, E. *Bugula robusta* var. *capensis* Waters. D, Basal view. E, Frontal view. The figures were drawn to the same scale, indicated by Busk as " 2 inch." According to the average of several measurements this represents a magnification of 23.5, now reduced to c. 17.5.

concavity in its profile at the beginning of the beak. The ovicells are like those of *B. robusta.*

Waters' first use of the name *Bugula capense* [*sic*], for a figure of a mandible. is almost a *nomen nudum.* He later published Busk's manuscript name, *Bugula capensis*, in a footnote, without formal description, but with indications that it possessed the specific characters of *B. robusta*, and that it came from S. Africa. All the S. African specimens of *B. robusta* that I have examined show the varietal differences enumerated above, and there is no evidence that typical *B. robusta* is ever found there. It may perhaps be assumed from this that the S. African specimens on which Waters based his remarks belonged to the variety, and if so the name *capensis* Waters would be available for the variety. Examination of the specimens in the Waters Collection confirms this assumption.

Although not known from S. Africa, typical *B. robusta* is found on the E. African coast, for examination of Waters' specimens confirms Harmer's opinion (1926, p. 435) that *B. neritina* var. *minima* Waters (1913, p. 471, but not 1909, see below) is a synonym of *B. robusta*. On the other hand, the specimens recorded as *B. robusta* by Waters on the same page are rather unlike the typical form. I have examined a specimen of Waters' *B. robusta* (text-fig. 275, D) lent me by the Manchester Museum. As the ancestrula and basal parts of the colony are not there it is not the slide figured by Waters (1913, pl. XIX, fig. 15) and may not be part of the same colony. I have been unable to trace the whereabouts

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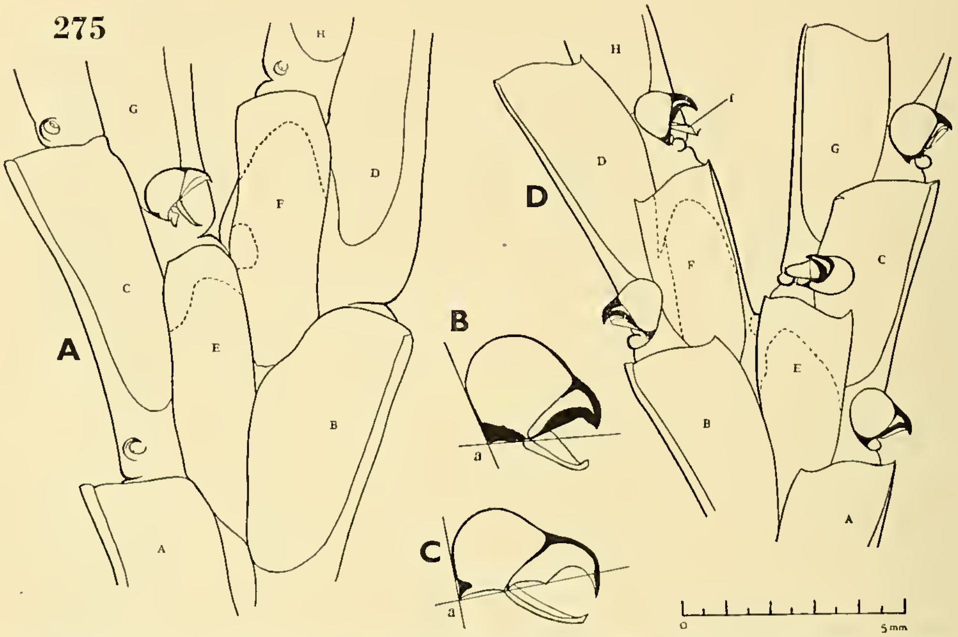


TEXT-FIG. 275.—A. *Bugula robusta* var. *capensis* Waters 99.7.1.305, showing small avicularium at bifurcation. B. a typical avicularium from the same specimen.——C. *B. robusta* MacG., avicularium from 79.5.27.1, Port Jackson.——D. *Bugula* sp. (*B. robusta* Waters 1913) Waters Collection Wasin, British E. Africa, 501.

a, lower head-angle. f, mandibular flange.

of the figured specimen. The zooecia are about the same size as those in the figure, but have more pointed distal corners. The avicularia appear to be smaller.

Harmer (1926, p. 443) suggested that the figure might represent *B. scaphoides*. The specimen examined by me (text-fig. 275, D) does not agree with that species. It unfortunately has no ovicells. In its bifurcation of type 5 it resembles *B. robusta*, and its avicularia have the general shape of those of *B. robusta* var. *capensis*, but the lower head-angle is more acute (compare text-fig. 275, B and D) and the mandible has a shoulder-like flange. The avicularia agree very closely with those of *B. subglobosa* Harmer, but the zooecia are not so narrow proximally and their inner distal corner is often pointed. The zooecia are nearer those of *B. subglobosa* than *B. robusta* in size, but the bifurcation of *B. subglobosa* is of type 4. The specimen from the Arabian Sea discussed on p. 337 suggests that the zooecia of *B. robusta* may sometimes be smaller than usual, and it may well be that the specimen from Wasin is a form of *B. robusta*.

Bugula neritina var. *tenuata* Thornely, which I have not seen, probably belonged to *B. robusta* var. *capensis*. The avicularian stalks are exceptionally long and slender in the figure, which otherwise agrees closely with var. *capensis*. The description also agrees except for a statement that the zooecia are "almost uniserial," which is disproved by the figure. Thornely's comparison of the zooecia with those of var. *rubra* further confirms the suggested synonymy, for var. *rubra*, which is represented in the British Museum by type material (1936.12.30.165), is a synonym of *B. robusta* (cf. Harmer, 1926, p. 435). The resemblance of var. *tenuata* to *B. robusta* was recognized by Harmer, who gave it as a synonym of that species.

2. **Bugula neritinoides** sp.n. (Busk MS.) (text-figs. 273, C, 274, A–C, 276, F.).

Type.—Tasmania, Mrs. Gatty (Busk Coll. 99.7.1.4648 and 4650).

Description.—Colony robust, rich brown in colour, biserial, with branching of type 4. Zooecia very flat frontally, without spines, outer corners very acutely pointed and with no tendency to turn forward. Opesia occupying at least three-quarters of frontal surface. Avicularia absent. Ovicells larger than zooecia, attached to inner distal corner of zooecium, globular, pedunculate, a calcareous border to the aperture, rest of ectooecium membranous.

Remarks.—According to Busk's draft description,[1] the colony of this species "spreads dichotomously into a circular expansion about 4 inches every way, strongly curled inwards at the edge [tips] of the branches." This remarkable colony is not in the Busk Collection, but the type slides were evidently made from it.

The long, pointed corners and very regular zooecia give the branches a characteristic feathered appearance (text-fig. 273, C; the apparently pale colour is due to the use of a filter for the photograph). The ovicells resemble those of *Bugula neritina* and related species in their general shape, but are gigantic. In the dried state, which is the only one in which I have seen the species, the ectooecium is collapsed and wrinkled (text-fig. 276, F), but even so the ovicells are distinctly larger than the zooecia that bear them. The figure is drawn to such a scale that the ovicell appears about the same size as those of other species in the same figure. Comparison of the size of the zooecia emphasizes the relatively gigantic size of the ovicell of *B. neritinoides*. The ovicell is closed by a dark brown membrane continuous with the frontal membrane of the zooecium, arising from a point proximal and lateral to the operculum.

In the general size of the zooecia and the robust scale of the colony *B. neritinoides* resembles *B. neritina* and *B. robusta*, but it has bifurcations of type 4.

3. **Bugula scaphoides** Kirkpatrick.

Bugula scaphoides Kirkpatrick, 1890, p. 18, pl. IV, fig. 1; Harmer, 1926, p. 443, pl. XXXI, figs. 7, 8, text-fig. 23*b*.

? *Bugula neritina* var. *ramosa* Thornely, 1912, p. 142, pl. VIII, fig. 3.

Distribution.—China Sea (Kirkpatrick; 89.8.21.13, 68, 69, type specimens; 1937.1.6.1); off New Guinea (Harmer; 28.3.6.289 and 290); ? Amirante (Thornely); ? Ghardaqa, Red Sea (Dr. C. Crossland, 1937.9.28.36); ? Mauritius (34.10.12.8).

B. scaphoides differs from the other species considered here in its sculptured ovicells.

[1] The description is written on the back of the drawing traced in figs. 274, A–C.

Ortmann (1892, p. 669) recorded a specimen with punctate ovicells, from Dar-es-Salaam, as *B. dentata* var. *africana.* His comparison with *B. dentata* implies the presence of spines and excludes the specimen from *B. scaphoides,* in which the ovicell is, in any case, better described as reticulate than as punctate.

On the other hand, it seems probable that *B. neritina* var. *ramosa* Thornely, described as having ovicells with a pitted surface, is a synonym of *B. scaphoides.* The type material of *B. scaphoides* is uniserial in part, and, both the type and the Siboga material, show lateral buds projecting from the sides of the zooecia at right angles, as in *B. neritina* var. *ramosa.* In the type of *B. scaphoides* this bud has given rise to a branch. Stout rootlets, as shown in Thornely's figure, are present in both sets of material. The zooecia agree in shape with those of *B. scaphoides,* and the dots on the ovicell in the figure might be a poor representation of the reticulation. I have not, however, seen a specimen of var. *ramosa.*

A fragment from Ghardaqa, Red Sea, resembles *B. scaphoides* in having reticulate ovicells (text-fig. 276, E), but they are smaller. The zooecia are also much smaller, and have a shorter proximal tubular part. The avicularia on the other hand, are about the same size, and, as in *B. scaphoides,* are attached to an unusually long peduncle, or outgrowth of the zooecial wall, which remains projecting quite conspicuously if the avicularium falls off (see spine-like projection from behind two of the ovicells in Harmer's fig. 7).

The specimen from Mauritius closely resembles the one from the Red Sea in its zooecia and avicularia, but has no ovicells. It differs from *B. crosslandi* with which it might, in the absence of ovicells, be confused, in the pointed outer (and sometimes inner) distal corners of the zooecia, in the long stalks of the avicularia, and in the presence of lateral branches and stout rootlets. The colony spread over the roots of a hydroid and was attached by the stout, thick-walled rootlets which spring from the basal surface, and are branched at their tips.

4. **Bugula minima** Waters (text-figs. 276, A–C, and 278, C).

Bugula neritina var. *minima* part Waters, 1909, p. 136, pl. XI, figs. 4, 6, 7 ; part (at least) Thornely 1912, p. 141 ; part Marcus, 1921, p. 1, pl. I, fig. 1.

Distribution.—Mersa Makdah,[1] Red Sea, 5 fms. (Waters ; Liverpool Museum) ; Ghardaqa, Red Sea, seaward edge of Outer Reef, low water spring-tide (Dr. C. Crossland, 1937.9.28.37) ; Dar-es-Salaam (Daressalam) (Marcus ; Stuhlmann, Berlin Mus. 1944 ; 1939.4.18.2) ; Providence, 50–78 fms. (Thornely ; Thornely Coll., 1936.12.30.166) ; Ceylon (99.7.1.4608).

Type.—Mersa Makdah (Liverpool University Museum).

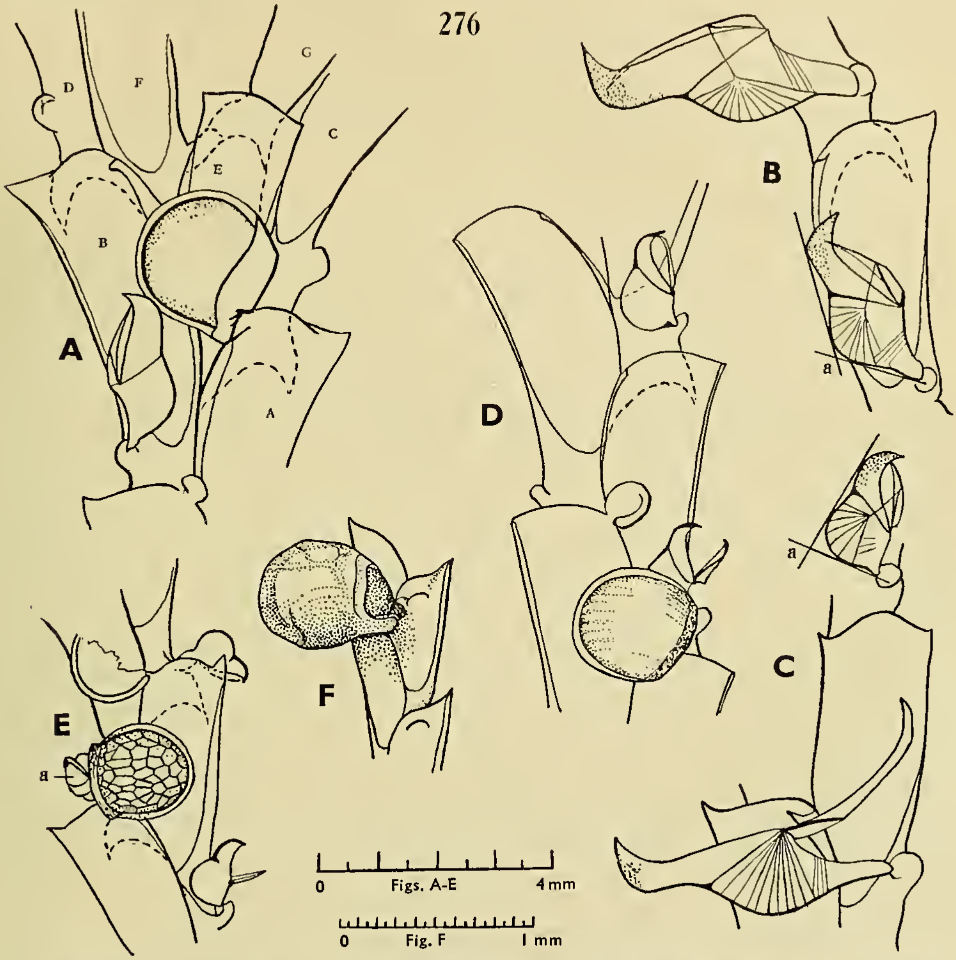
Description.—Colony, biserial with branching of type 4. Zooecia with outer distal corner pointed, inner corner rounded or pointed. Opesia occupying nearly the whole frontal surface. Brown pigment in tissues persisting in spirit. Avicularium springing from side of zooecium, distal to proximal expansion, and level with proximal end of opesia, large and long, strongly curved dorsally, upper head-angle variable, hooked beak forming at least half the total length. A few very large avicularia of similar shape to those with the more obtuse upper-head-angle, or with even flatter head (text-fig. 276, B, C). Ovicells attached to inner distal corner of zooecium, oval, pedunculate, with thickened band round aperture.

[1] Name of locality corrected, Waters, 1910, p. 254.

Synonymy.—Waters used the name *B. neritina* var. *minima* for specimens, which I have examined, of three distinct species.

1. The specimen from Mersa Makdah shown in Waters' figures[1] 4, 6 and 7, to which I restrict Waters' name, giving it specific rank (text-fig. 276, C).

2. The specimen from Khor Dongola shown in his figure 5 which belongs to *B. crosslandi.*



TEXT-FIG. 276.—A–C. *Bugula minima* Waters. B and C show large and small avicularia with parts of surrounding zooecia. A and B from specimen from Ghardaqa, 1937.9.29.37. C from type specimen from Mersa Makdah, Red Sea.——D. *Bugula crosslandi* sp.n. part of Waters' specimen from Khor Dongola (Liverpool University Museum).——E. *Bugula ? scaphoides* 1937.9.28.36, from Ghardaqa. One ovicell incomplete. Note long avicularian stalks. a. avicularium partially hidden by ovicell.——F. *Bugula neritinoides* sp.n. part of type specimen 99.7.1.4648.
a. (in B and C) upper head-angle.

3. The specimens from Prison Is. and Ras Osowamembe, Zanzibar (1913), which belong to *B. robusta*, as stated by Harmer, 1926.

As noted by Waters, the specimens from Khor Dongola have " somewhat smaller zooecia and much smaller avicularia " than those from Mersa Makdah. In addition, *B. crosslandi* differs from *B. minima* in its shorter opesia and the

[1] Waters gives Khor Dongola as the locality for his figures 4 and 5, but the actual zooecia figured can be recognized in his slides, and figure 4 is drawn from the same specimen from Mersa Makdah as figure 6.

position of the avicularium relative to it, in the less-pointed distal corners of the zooecia, and the uniform size of the avicularia. The differences between the two species are quite obvious when actual specimens are examined, and can mostly be distinguished in Waters' figures. Harmer attributed all these forms to *B. robusta*, but *B. minima* and *B. crosslandi* are more delicate forms with smaller zooecia of different shape, smaller avicularia, and different bifurcation.

Marcus also confused more than one species under *B. neritina* var. *minima*. I have examined his specimens and find that he had :

1. Specimens, from Dar-es-Salaam, of typical *B. minima* as here understood.

2. Material of *B. neritina* which was mixed with the *B. minima* from Dar-es-Salaam.

3. Specimens of *B. robusta* from Bagamoyo (Berlin Museum, 1949) and from Gaspar Straits (Riksmuseum, Stockholm, No. 693).

His specimens of *B. robusta* agree very closely with a specimen from Siboga St. 164 (28.3.6.272), in which the avicularia are borne on long stalks at about the middle of the side of the zooecium and cusps are absent or evanescent.

Marcus' figure represents a form in which the zooecia are about half the size of those of his specimens of *B. robusta*, and the avicularia, which have a much flatter head (upper head-angle obtuse in contrast to the acute angles of the specimens of *B. robusta*), are attached by short stalks near the proximal end of the zooecium. It was evidently drawn from the material from Dar-es-Salaam and was, indeed, recognizable as *B. minima* without the examination of specimens which has since confirmed this conclusion. The structures in the figure which might be taken for cusps like those of *B. robusta* appear to be the median sense-organs.

The specimen from Providence, recorded as *B. neritina* var. *minima* by Thornely (1912), agrees very closely in the shape of avicularia and ovicells, but does not possess any of the exceptionally large avicularia. The zooecia are rather slender and do not widen so much distally, and the outer distal corner is correspondingly more obtuse. Of the specimens recorded by Thornely (1905, 1907, 1912) as *B. neritina* with avicularia, I have only seen the specimen from Amirante (Cambridge Museum) which belongs to *B. robusta*. Harmer puts them all in *B. robusta*. I have no evidence about the specimen similarly recorded by Philipps (1899).

Specimens have also been recorded under this varietal name by Osburn (1914, p. 187), and by Okada and Mawatari (1938, p. 451), but these identifications need confirmation now that the name is more strictly defined.

Remarks.—This species differs from related forms in the size, shape and position of its avicularia (see key) and the shape of the zooecia. There are no ovicells in the type, but those of other specimens have a broad thickened border to the ectooecium (text-fig. 276, A).

In the type specimen the small avicularia are smaller and have a rounder head (more acute upper head-angle) than those of the other specimens (cf. text-fig. 276, B and C). The large avicularium in text-fig. 276, B, is smaller than others on the same specimen, which shows as great a contrast between the two sizes as in the type. In Marcus' material some of the large avicularia are even bigger than those figured, and have a more obtuse upper head-angle. The small avicularia are like those from Ghardaqa. The fragments from Ceylon have avicularia of the same shape as the small ones of the type, and have no large avicularia.

The colony from Ghardaqa springs by a short stalk from rootlets ramifying in a sponge. The stalk (text-fig. 278, C) is an elongated zooecium with lateral thickenings like those of certain related species. It has a blunt thickened end, whose appearance suggests that it may have healed after breakage. It is thus not clear whether the stalk is an ancestrula or has been budded from the tangle of stout rootlets in the sponge. One stout rootlet arises from the stalk and passes into the sponge.

5. **Bugula crosslandi** sp.n. (text-figs. 276, D, and 277, A).

Bugula neritina var. *minima* part Waters 1909, p. 136, pl. XI, fig. 5 ; part Hastings 1930, p. 704, pl. II, fig. 6.

Not *Bugula neritina* var. *minima* Thornely 1912, p. 141 (part at least = typical *B. minima*) ; Waters 1913, p. 471 (= *B. robusta*) ; Marcus 1921, p. 1 (= typical *B. minima* and *B. robusta*).

Distribution.—Abu Shaar, Red Sea, ½–1 fm., May 20, 1933 (Dr. C. Crossland, 1937.9.28.35) ; Khor Dongola, Red Sea (Waters ; Liverpool Mus.) ; Zanzibar (Hincks Coll., 99.5.1.407) ; Gorgona (Hastings ; 29.4.26.43, 245).

Type.—1937.9.28.35.

Description.—Colony delicate, biserial, with branching of type 4. Zooecia without spines or strongly pointed corners. Opesia occupying at least three-quarters of frontal surface. Avicularium springing from proximal gymnocyst, at a point distal to proximal expansion, but proximal to opesia, with rounded head and hooked beak of moderate length. Ovicell attached to inner distal corner of zooecium, globular, pedunculate, with thickened band round aperture.

Synonymy.—The agreement of Waters' specimen from Khor Dongola (text-fig. 276, D) with the type is very close. The British Museum specimen from Zanzibar (see Hastings 1930) also agrees closely with the type, but the rather more robust one from the Arabian Sea (99.5.1.406) appears to belong to *B. robusta*. Although it is not so robust as most specimens of that species, it much resembles, both in size and shape, Harmer's figure (1926, pl. XXXII, fig. 3) of a specimen with evanescent cusps. It agrees with *B. robusta* in its bifurcation and the shape of the zooecia. The avicularia are placed, in the position commonest in *B. robusta*, on the proximal gymnocyst just distally to the constriction. The presence of this marked constriction is in itself a point of agreement with *B. robusta*. In *B. minima* and *B. crosslandi* the zooecium tapers until it rather suddenly widens to the proximal expansion. In *B. robusta* the lateral wall curves outward a little before turning sharply inward to a constriction that marks off the proximal expansion. Both the position of the avicularium and the outline of the zooecium as here described can be seen in my figure of *B. robusta* var. *capensis* (text-fig. 275, A).

It is rather surprising to find *B. crosslandi* in the Pacific, but the specimen from Gorgona (text-fig. 277, A) agrees quite closely with the type. The avicularia are a little smaller and more slender. The specimens from Galapagos 9 (29.4.26.246) are young colonies of some other species, in which the bifurcation is of type 3, the avicularia are attached at the side of the opesia at about the middle of the length of the zooecium, and spines are present.

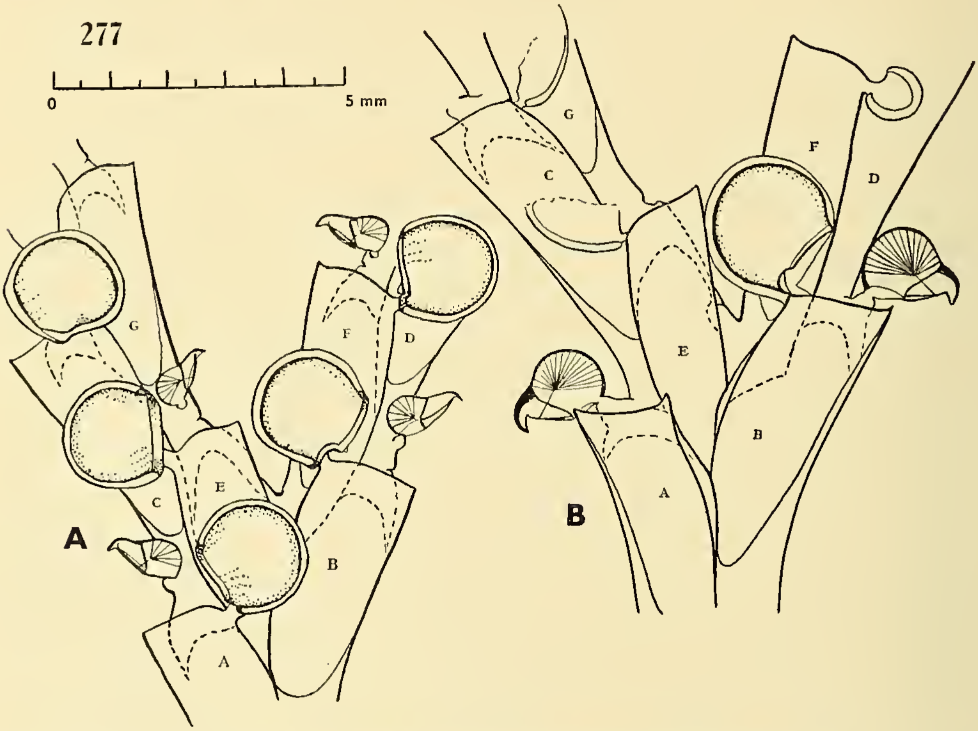
Remarks.—The points in Waters' drawings which might be taken as a poor representation of the avicularian cusps of *B. robusta* are evidently intended for the condyles, to which the mandible is articulated, which are rather conspicuous in his specimen.

B. crosslandi is distinguished from *B. expansa* by the absence of the foot-like basal attachment, and by its smaller avicularia, with flatter head and longer beak, attached to the proximal gymnocyst at a little distance from the proximal expansion (cf. text-figs. 277, A, B).

With the exception of Hincks' specimen from Zanzibar, all the material of this species known to me has been collected by Dr. C. Crossland, after whom it is named.

6. **Bugula expansa** sp.n. (text-figs. 277, B, and 278, B).

Type.—British Antarctic Expedition (" Terra Nova "), St. 134, Spirits Bay, near North Cape, New Zealand, 20–37 m., August 31, 1911, 1939.2.2.2.



TEXT-FIG. 277.—A. *Bugula crosslandi* sp.n., part of the specimen from Gorgona 29.4.26.43.—— B. *Bugula expansa* sp.n., part of the type specimen, 1939.2.2.2. One immature and two incomplete ovicells are shown.

Description.—Colony biserial, with branching of type 4, attached by large, flat, more or less pear-shaped foot (text-fig. 278, B). Foot with very thin calcareous wall, and thick crust-like calcareous border which easily breaks away. Interior of foot filled with yellow, granular material. A thick-walled, yellow tube rising vertically from narrow end of foot, connected with first zooecium by a joint. Rootlets sometimes attached to substratum by similar, but smaller and more irregularly shaped, feet. First zooecium elongate, with long opesia and no avicularium, giving rise to two normal zooecia. Zooecia (text-fig. 277, B) with outer distal corner slightly pointed, inner distal corner usually rounded, sometimes pointed. Opesia extending nearly to proximal end of zooecium. Avicularium springing from outer side of proximal expansion of zooecium. Head of avicularium round, beak hooked, shorter than that of

B. crosslandi. Ovicells attached to inner distal corner of zooecium, globular, pedunculate, with a thickened band round aperture.

Remarks.—A number of small colonies were growing on the concave surface of shells.

The zooecia of this species are similar to those of *B. crosslandi*, and the two species agree in their ovicells and pigmentation. The avicularia of *B. expansa* are larger, have a rounder head and shorter beak, and are attached to the proximal expansion of the zooecium. The two species also differ in the characters of the base of the colony (cf. text-fig. 278, B, and Hastings, 1930, pl. II, fig. 6).

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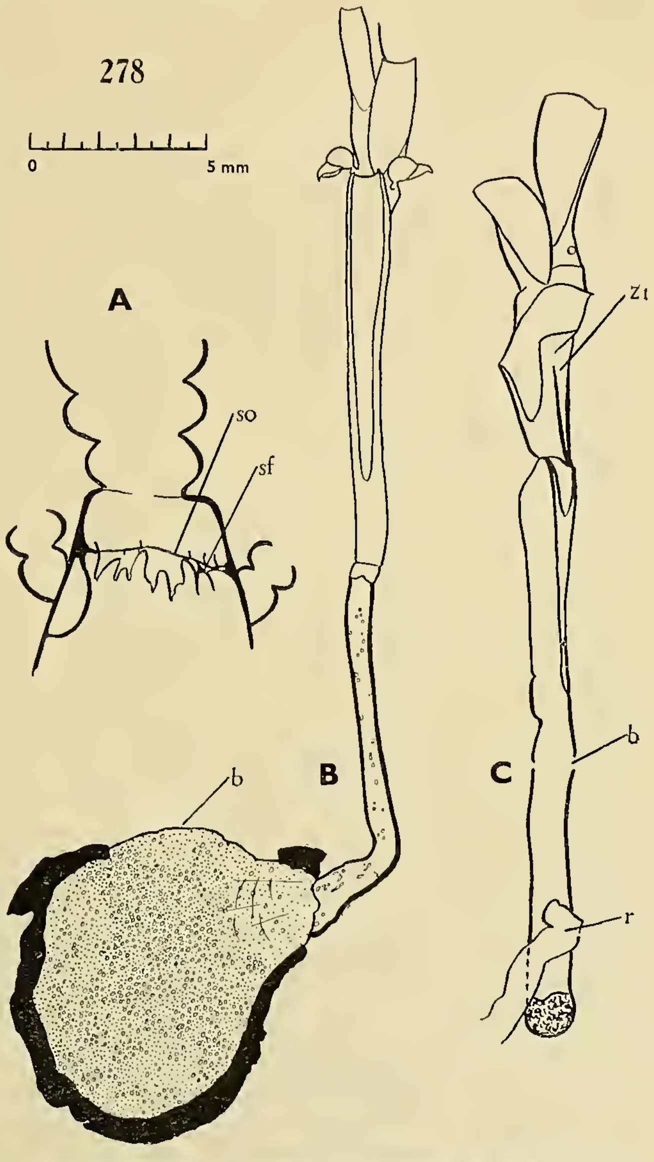


Text-fig. 278.—A. *Caulibugula annulata*. 97.5.1.345, Port-land Victoria. Septum between two main stalk-kenozooecia and bases of two lateral stalk-kenozooecia. so, septum in optical section. sf, fringed insertion of septum on lateral wall.——B. *Bugula expansa* sp.n. Base of type colony 1939.2.2.2. Calcareous crust shown black, broken away at b.——C. *Bugula minima* Waters, base of colony from Ghardaqa, 1937.9.28.37. The first zooecium is bent and the stalk or ancestrula is broken at b. r, rootlet.

Caulibugula Verrill 1900.

1. **Caulibugula zanzibariensis** (Waters).

Stirparia zanzibariensis Waters, 1913, p. 469, pl. LXVIII, figs. 1, 2, pl. LXIX, fig. 14.
Stirpariella zanzibariensis Marcus, 1925, p. 53.
Caulibugula zanzibariensis Harmer, 1926, p. 460, pl. XXXIII, figs. 5–10.
Bicellaria glabra Busk, 1884, p. 35, pl. VI, figs. 1, 1*a* (not *Stirparia glabra* Hincks).

Distribution.—Chuaka, Zanzibar (Waters); Kurrachee (83.9.13.33); Java (Harmer; 28.3.6. 306, 307, 308); off Bahia (Busk; 87.12.9.168, 169).

The Challenger specimen from off Bahia, recorded by Busk as *B. glabra* (Hincks), differs from the type specimen of Hincks' species in the shape of its opesia, in the number and position of its spines, in the shape and position of its avicularia, in the way in which the first zooecia place themselves back to back, forming a cone with the zooecia facing outward, and in its more delicate appearance. Several of these points are distinctly shown in Busk's figure, and in all of them the specimen resembles *C. zanzibariensis*, agreeing very exactly with Harmer's description, except perhaps in the absence of stem vesicles. Short rootlet-like structures with slightly inflated tips are, however, present.

In addition to the unmounted specimen of *C. zanzibariensis* (87.12.9.169) and two slides of its kenozooecia (87.12.9.169 part and 168), the Challenger material labelled *C. glabra* and purporting to come from Bahia includes a slide of *C. annulata* (87.12.9.167), as noticed by Waters (1913, p. 468). Waters, who evidently did not see the unmounted specimen, was puzzled by not finding material corresponding to Busk's figure, and by the presence of *C. annulata*. Noticing that the slide of *C. annulata* had been relabelled, apparently in haste, by Busk, I examined the underneath labels. This revealed that the slide was originally labelled Port Jackson, but this had been crossed out and Bahia substituted. In view of this evidence of uncertainty about the locality, I think there is no good reason to accept *C. annulata* as having been obtained off Bahia. It is also worth noticing that Busk expressly states that he only had one specimen of his supposed *C. glabra*.

C. annulata was obtained by the Challenger from St. 161 (Port Phillip, 1938.11.24.1 and 2), but this material was left unnamed by Busk.

The young colony from the Barrier Reef compared by Hastings (1932, p. 408) with *C. zanzibariensis* is further distinguished from that species by the first zooecium of the fan which is *Bugula*-like and not markedly different from the succeeding zooecia, cf. the W. Australian specimen discussed by Harmer (1926, p. 461).

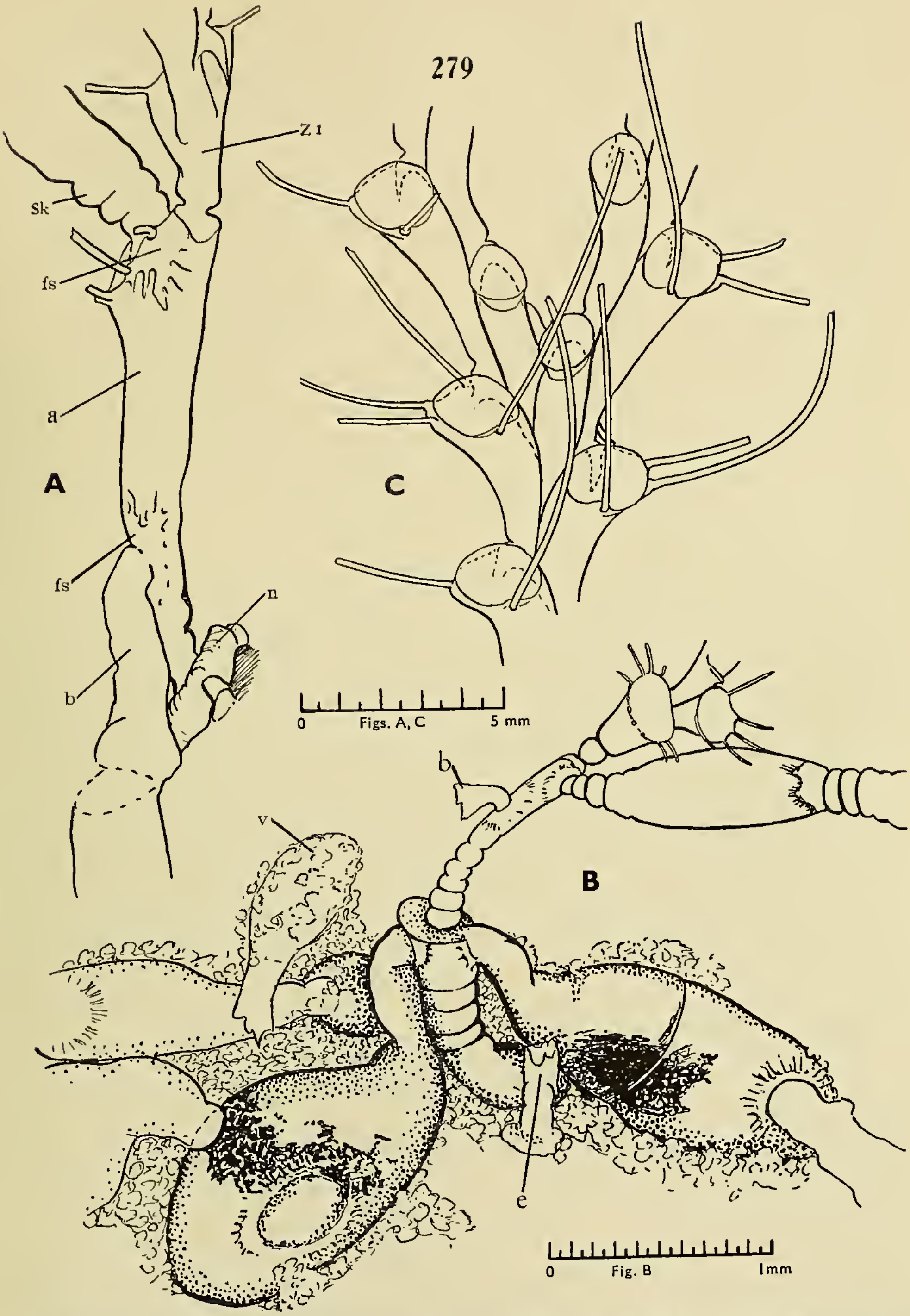
2. **Caulibugula tuberosa** sp. n. (text-fig. 279, A–C).

Type.—Discovery St. 934, 34° 11′ S., 172° 10′ E. (New Zealand), 17.viii.32. 98 m. (1939.2.2.1).

Description.—Colony attached by stout, vesicular, rootlet-like kenozooecia. Stalks short, stalk kenozooecia stout, annulated proximally without calcareous thickenings. Bifurcation of Harmer's type 5. Zooecia bicellarielliform, opesia almost circular, occupying considerably less than half the length of the zooecium, sometimes with thin raised border. Spines long and curved, 0–1 proximal, 0–4 outer, 0–1 distal, the latter directed basally, zooecia bordering axil usually spineless. Ancestrula turbinate, tubular portion fairly long, annulated proximally, with spines on proximal and lateral borders of opesia. First zooecium of fan turbinate, but short, annulated or merely constricted proximally, with variable spines.[1] Avicularia absent. Ovicells unknown.

Remarks.—The material consists of two colonies growing on a stone. They were apparently more or less surrounded by a sponge, now mostly cleared away. Text-fig. 279, A and B, shows the bases of the colonies, and in B the remains of the sponge in the interstices are indicated. The smaller colony (text-fig. 279, A) has a turbinate ancestrula, attached by proximal rootlets and giving rise distally to a fan and a stalk-kenozooecium. It is curious that the stalk-kenozooecium appears to spring from the opesial surface of the ancestrula, being encircled by the spine-bearing border of the aperture. The first zooecium of the fan has a proximal constriction, and the ancestrula and stalk-kenozooecium are both

[1] There are, for example, 4 spines on one side of the aperture and one on the other in one instance, and in another (text-fig. 279, B) 9 spines are ranged in a single series.



TEXT-FIG. 279.—*Caulibugula tuberosa* sp.n. Type specimens 1939.2.2.1.——A. Base of younger colony. a, ancestrula. b, buttress (torn). fs, fringed septum. n, rootlets. sk, stalk-kenozooecium zi, first zooecium of fan.——B. Base of older colony. e, broken base of second erect tube. v, detached vesicle of buttress (b) from thinner part of stalk.——C. Zooecia from the younger colony.

annulate proximally. From the side of the ancestrula arises a stout rootlet-like structure which drops, like a buttress, to the stone and there expands into a vesicle (torn in mounting as shown in figure).

The older colony (text-fig. 279, B) has a stout, annulate stalk, with thick, dark brown walls. From its truncated end springs, as if by regeneration, a more slender thin-walled kenozooecium which gives rise in its turn to a fan and a stalk, the latter consisting of two kenozooecia and ending in the first zooecia of a fan. Buttresses from the thick part of the stalk have thick walls and form large thick-walled darkly pigmented vesicles on the stone. From these arise thin-walled vesicles, which are also encrusting, and one erect tube (*e*), which has formed a small buttress, but is broken short. A thin-walled buttress (*b*) and vesicle (*v*, now broken) arise from the thinner part of the main stalk.

It is generally agreed that the stalk segments of *Caulibugula* are kenozooecia, and the Californian species *C. ciliata* (Robertson) affords some support to this view, as its kenozooecia have a small vestigial opesia, often with marginal spines. In the relation of the kenozooecia to the fans and in the general structure of the colony *C. ciliata* agrees with other species of *Caulibugula*. I have examined a specimen of *C. ciliata* sent to the British Museum by Dr. Amy Blagg (1938.11.30.8).

The stem kenozooecia of *C. tuberosa* resemble those of *C. annulata* (text-fig. 278, A), but are much smaller. In both species the transverse septum between one kenozooecium and the next has so irregular a line of attachment to the lateral wall that it can only be described as fringed (cf. *C. caraibica* Levinsen 1909, pl. III, figs. 2*h–j*). It is at once noticeable that the buttresses and vesicles of *C. tuberosa* spring from similar fringed discs, and I therefore conclude that they, too, are probably to be regarded as kenozooecia.

Harmer (1926, p. 463) described the much more root-like basal structures of *C. exilis* and concluded that they were composed of kenozooecia. Traces of fringing can be detected both in the type material from Port Nepean (97.5.1.347, 348) and in Harmer's material (28.3.6.309), and it seems probable that *C. tuberosa* represents a condition of the kenozooecial system intermediate between those of *C. exilis* and *C. annulata*, and affords valuable confirmation of Harmer's conclusion. The specimens of *C. exilis* were immersed in sponges up to the base of the fans. One is tempted to relate the condition in *C. tuberosa* to its less complete immersion.

In zooecial characters *C. tuberosa* is near *C. annulata*, which it resembles in the rounded opesia and the number and distribution of the spines (text-fig. 279, C). The zooecia are very much smaller, with a relatively longer tubular portion, and they do not have the forked thickening in the basal wall. The whole growth is much more delicate. *C. exilis* has a longer opesia with a different arrangement of the spines.

The four species mentioned here (*C. annulata*, *C. tuberosa*, *C. exilis*, *C. ciliata*) agree in the absence of longitudinal calcareous thickenings in the walls of the kenozooecia. In this they apparently resemble the form ascribed by Osburn (1914, p. 188) to *C. armata* Verrill. Thickenings are, however, shown by Marcus (1938, p. 29) in what he believes to be the same species. In any case, Osburn's species is distinguished from *C. tuberosa* by the shape of the opesia, and the number and arrangement of the spines. It has avicularia. Fringing is not described in the kenozooecia of *C. armata* and is absent in *C. ciliata*.

REFERENCES.

Busk, G. 1852*a*. An Account of the Polyzoa and Sertularian Zoophytes. In J. MacGillivray, *Narrative of the Voyage of H.M.S. Rattlesnake*, I. *Appendix*, 59 pp., 1 pl.

—— 1852*b*. *Catalogue of Marine Polyzoa in the Collection of the British Museum*, I. London.

—— 1884. The Cheilostomata. *Rep. Zool. Chall. Exp.*, XXX.

Cranwell, L. M., and Moore, L. B. 1938. Intertidal Communities of Poor Knights Islands, New Zealand. *Trans. Roy. Soc. N.Z.*, LXVII, pp. 375–407, 2 pls. 3 figs., 1 table.

Gray, J. E. 1843. Additional Radiated Animals and Annelides, in Dieffenbach, E. *Travels in New Zealand*, II, pp. 292–295.

Harmer, S. F. 1915. Entoprocta, Ctenostomata, Cyclostomata. *Rep. Siboga, Exp.*, XXVIII*a*.

—— 1923. On Cellularine and other Polyzoa. *J. Linn. Soc. London*, XXXV. pp. 293–361, 4 pls.

—— 1926. Cheilostomata Anasca. *Rep. Siboga Exp.*, XXVIII*b*.

Hasenbank, W. 1932. Bryozoa der Deutschen Tiefsee Expedition, Teil I. *Wiss. Ergebn. Deutsch. Tiefsee-Exped.*, XXI, 2, pp. 319–380, 1 pl. 35 text-figs.

Hastings, A. B. 1930. Cheilostomatous Polyzoa from the Vicinity of the Panama Canal. . . . *Proc. Zool. Soc. London*, 1929, part 4, pp. 697–740, 17 pls.

—— 1932. The Polyzoa. . . . *Rep. Barrier Reef Exp.* 4, No. 12, pp. 399–458, 1 pl., 20 text-figs.

Hincks, T. 1881. Contributions towards a General History of the Marine Polyzoa, V. *Ann. Mag. Nat. Hist.* (5), VII, pp. 156–161, 3 pls.

—— 1891. South African and other Polyzoa. *Ann. Mag. Nat. Hist.* (6), VII, pp. 285–298, 2 pls.

Kirkpatrick, R. 1890. Report upon the Hydrozoa and Polyzoa collected . . . in the China Sea. *Ann. Mag. Nat. Hist.* (6), V, pp. 11–24, 3 pls.

Kluge, H. 1914. Die Bryozoen. . . . *Deutsche Südpolar-Exped.*, XV, 7, pp. 601–678, 8 pls., 47 text-figs.

Levinsen, G. M. R. 1909. Morphological and Systematic Studies on the Cheilostomatous Bryozoa. Copenhagen.

Livingstone, A. A. 1929. Bryozoa Cheilostomata from New Zealand. *Vidensk. Medd. naturh. Foren. Kjøb.*, LXXXVII, pp. 45–104, 2 pls., 7 text-figs.

MacGillivray, P. H. 1869. Descriptions of some new Genera and Species of Australian Polyzoa. . . . *Trans. Proc. Roy. Soc. Vict.*, IX, pp. 126–148.

—— 1881. In McCoy, *Prodromus Zool. Victoria*, Dec., VI, pp. 27–46, 4 pls.

Marcus, E. 1925. Über *Stirpariella mortenseni* und das Genus *Stirpariella*. *Vidensk. Medd. Dansk. Naturh. Foren.*, LXXXI, pp. 37–55, 12 text-figs.

—— 1938. Bryozoarios Marinhos Brasileiros, II. *Bol. Fac. Phil. Sc. Letr. Univ. S. Paulo*, IV, Zool. 2, pp. 1–137, 29 pls.

Okada, Y., and Mawatari, S. 1938. On the Collection of Bryozoa along the coast of Wakayama-ken, the middle part of Honsyu, Japan. *Annot. Zool. Jap.*, XVII, pp. 445–462, 1 pl., 7 text-figs.

Ortmann, A. 1892. Die Koralriffe von Dar-es-Salaam und Umgegend. *Zool. Jahrb. Jena*, Syst. 6, pp. 631–670, 2 text-figs.

Osburn, R. C. 1914. The Bryozoa of the Tortugas Islands, Florida. *Pap. Tortugas Lab. Carn. Inst.*, V, pp. 183–222, 23 text-figs. (Carnegie Publ. 181).

Philipps, E. G. 1899. Report on the Polyzoa from the Loyalty Islands, New Guinea and New Britain. *Willey's Zool. Res.*, IV, pp. 440–450, 2 pls.

Thomson, Wyville T. C. 1858. On New Genera and Species of Polyzoa. . . . *Nat. Hist. Rev. London*, V, *Proc. Societies*, pp. 134–147, 5 pls.

Thornely, L. R. 1905. Report on the Polyzoa. . . . in Herdman, *Rep. Pearl Oyster Fisheries Gulf of Manaar*, IV. *Suppl. Rep.*, XXVI, pp. 107–130, 1 pl.

—— 1907. Report on the Marine Polyzoa in the collection of the Indian Museum. *Rec. Ind. Mus.*, I, pp. 179–196, 8 text-figs.

—— 1912. The Marine Polyzoa of the Indian Ocean from H.M.S. *Sealark. Trans. Linn. Soc. London*, XV, pp. 137–157, 1 pl.

Waters, A. W. 1887. Bryozoa from New South Wales, N. Australia, etc. Pt. 1. *Ann. Mag. Nat. Hist.* (5), XX, pp. 81–95, 1 pl.

—— 1909. Reports on the Marine Biology of the Sudanese Red Sea. . . . I. *J. Linn. Soc. Zool.*, XXXI, pp. 123–181, 9 pls.

—— 1910. Op. cit., II. *J. Linn. Soc. Zool.*, XXXI, pp. 231–256, 2 pls.

—— 1913. The Marine Fauna of Brit. E. Africa and Zanzibar. . . . Bryozoa. *Proc. Zool. Soc. Lond.*, pp. 458–537, 10 pls.